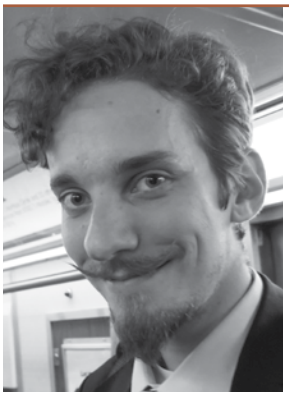
An Exoskeleton with a TWIST

BY PETR VANCURA

A new torquing tower in Manhattan's Meatpacking District echoes the angles of neighboring streets.

837 WASHINGTON STREET is a symbol of the ever-changing and ever-modernizing Meatpacking District in Manhattan.

Situated across the street from High Line Park (see "Elevated Experience" in "What's Cool in Steel," 08/09), the project is a six-story office and retail development designed by Morris Adjmi Architects and built by Sciame Construction for Thor Equities and Taconic Investment Partners. Gilsanz Murray Steficek (GMS), which served as structural design engineer, was intensely involved in the construction phase and provided special inspection services including steel erection and structural safety.



Petr Vancura (petr.vancura@gmsllp.com) is director of communications with Gilsanz Murray Steficek.

The building is a new torquing tower that rises out of an existing two-story Art Moderne-style brick warehouse built in 1938, which was once part of the Gansevoort Market.

With 12-ft-plus ceiling heights throughout, the building consists of 28,000 sq. ft of retail space, 27,000 sq. ft of office space and more than 7,000 sq. ft of roof deck and terraces. Two passenger elevators, rooftop cooling towers and mechanical equipment are also accounted for in the structural design. Structural work on the project was completed last September, and the estimated total project cost was $96 million.

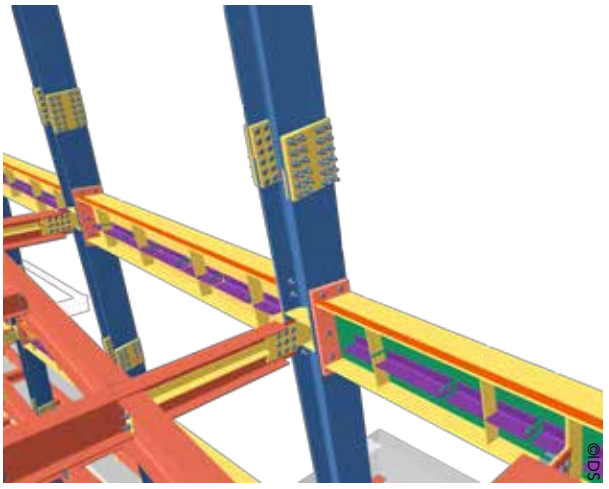
To comply with complex landmark restrictions, the design team preserved the original masonry façade, created new masonry openings at street level and restored cantilevered canopies that are signature to the neighborhood. This lower retail structure frames into a new steel exoskeleton of sloping columns and twisted floor plates that comprise the upper office component of the building.

The preservation of the 100 linear ft of the existing landmarked façade involved front and back bracing and underpinning to enable deeper excavation and new basement construction consisting of a 2-ft, 6-in. foundation mat and 10-in.-thick perimeter liner walls below the preserved storefront. Additionally, existing roof areas had to be reframed to create tenant terraces at the intended elevations.

▲ Tapered shims applied between connector plates.

◄ A view from the street...

▼ ...and from the High Line.



▲ A steel connection detailing model.

▼ Twisting floor plates pivot around a masonry core.

Torquing Torso

The unique torso of 837 Washington provided opportunities for creative approaches to its structural design. Steel perimeter girders are positioned so as to pivot around the axis of a brick-clad core, which ties back into the warehouse structure below. The natural rotation created by this geometry is resisted by braced frames at the core, and the twisting floor plates were designed to echo the angles of neighboring streets. Morris Adjmi's design was inspired by the dichotomy between the perpendicularity of the 1811 Commissioners' Plan street grid north of the Meatpacking District and the organically angular street patterns to the south. Whereas the building base expresses the grid, the upper floors refer to the village street condition.

The columns of the exterior frame span only a single story, rather than the two stories typical of steel construction, in order to accommodate the twisting geometry. Not only are they sloped, but as the frame's geometry rotates around the building, the columns also pivot by about 5° on the axis of the column below. Tapered steel shims have been applied between splice plates and columns at these connections both inside and outside of the flanges.

The nature of the sloped column design results in a tendency for the building to twist under its own weight and occupancy. While some movement may be acceptable, the tolerance of this rotation had to be engineered so as not to damage windows in the curtain wall. In order to arrive at the most effective design and achieve highly flexible interior layouts, multiple schemes were presented to the clients that would eliminate the need for interior columns as much as possible. One such option was to pitch the interior columns at the building core in the opposite direction so as to counteract the dynamics of the exterior's twist. However, this scenario would have used up too much free-and-clear floor area at the interior due to the sizes needed. Instead, GMS proportioned the beams and columns to attain the necessary stiffness, situating cross-bracing around the building core, out of the way of interior use. The structure is engineered for live loads higher than required in order to allow for greater flexibility of future use at the retail levels.

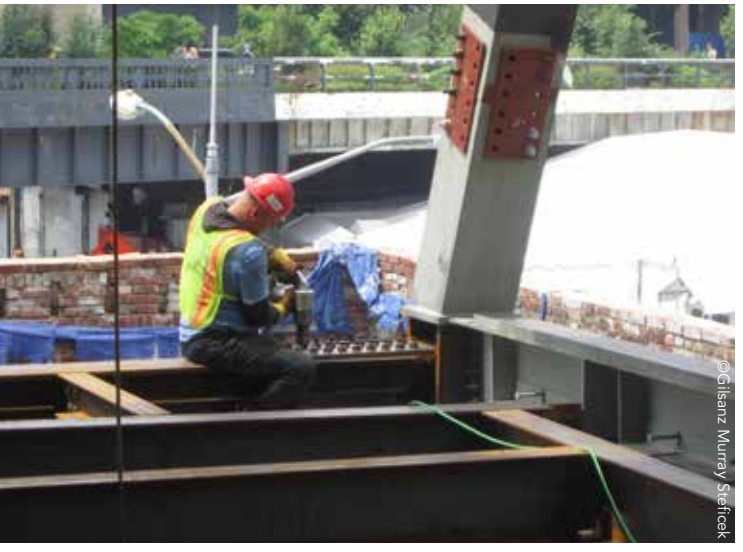
Thwarting Thermal Bridging

One consequence of using an exoskeleton system is that the steel frame is exposed to the elements and is prone to thermal conductivity. To minimize this conductivity, only the beam web is allowed to pass through the building envelope, and high-strength non-metallic carbon fiber thermal break shims were used at these connections. (The thermal analysis of this connection was performed by Frank Seta and Associates.) The exterior steel is fireproofed using intumescent epoxy based on Morris Adjmi's design specification.

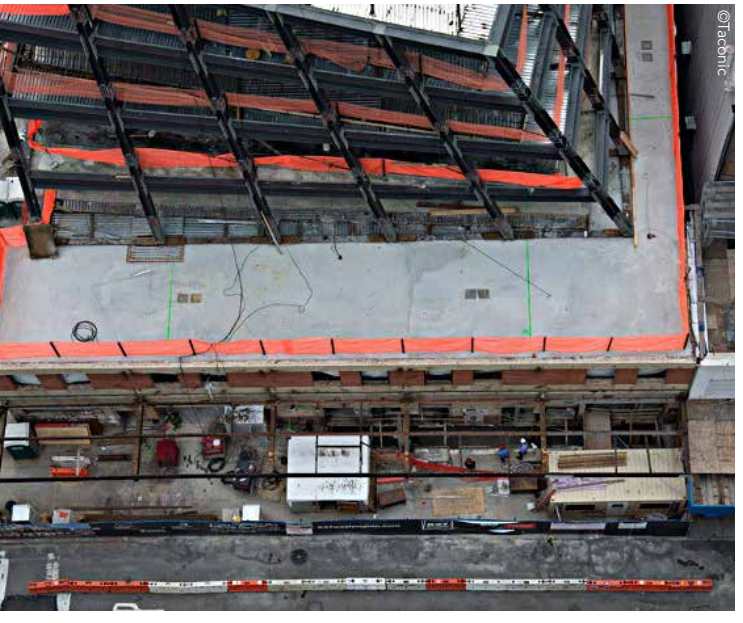
The intricate design at the building perimeter was achieved by innovative plate girders. The skewed profile of these customized

▲ The curtain wall behind the exoskeleton.

▼ Bolting the frame.



▼ New steel at the upper levels frames into the preserved existing façade at the lower levels.



girders allowed the architectural/visual perpendicularity of the design to be maintained. To maximize usable retail space and overall stability, the sloped columns of the superstructure transfer thrust to straight columns at the second floor. This created a more efficient frame design and maximized the retail space. The prefabricated transition consists of a 1.5-in.-thick base plate welded to a 7-ft sloped column segment. In the field, this assembly was bolted to sloped columns above and welded onto vertical columns below.

The built-up profiles are more efficient and accommodating than conventional sizes. The clear floor height was further maximized by varying the direction of deck framing, thus decreasing the necessary depth of supporting beams.

Demanding Details

Due to the elaborate design, even a tiny misalignment during construction would potentially have repercussions further up the structure. This work therefore demanded special attention to minute details (from connections and splices to individual bolt orientation) in order to sustain the necessary forces involved, attain the design's aesthetic and implement an efficient construction process.

GMS offered an innovative compromise between the architect's ambition of field-welding all exterior steel connections and the developer's desire to reduce costs using less attractive, typical bolted moment connections: The end plates that tie the custom girders to the sloped columns were welded off-site, requiring the members to be merely bolted together in the field.

This structure was modeled in Autodesk Revit and Rhino, allowing intricate, accurate, 3D interactions of all elements to be engineered precisely. Despite the complex design criteria, construction was completed on time, and the design team endeavored to make the erection process as similar to standard construction as possible.

The building is designed to achieve LEED Gold certification, incorporating the support of planter beds along the edges of the floor slabs that reduce storm water runoff, as well as roofs that are designed to sustain rainwater retention loads. Logistically, despite being situated on a tight urban site, construction was achieved efficiently, with minimal disruption to the immediate streets and surrounding neighborhood. The foundation mat was poured in a single day (on a Saturday), at which time only one lane was blocked along West 13th Street. During superstructure erection, the pre-welded components reduced potential traffic congestion that would have arisen from extensive staging and storage of steel in the case of field welding connections, and the streets remained open for traffic throughout the construction process.

The structure exists contextually within its built environment. Adjmi's concept and GMS's execution produced a building expressive of the up-and-coming retail center that is the Meatpacking District. It stands as a case study of melding old with new via a steel framing approach that serves as both an innovative aesthetic and a standard erection process—while at the same time respecting neighborhood context. ■

Developers
Taconic Investment Partners, Thor Equities

General Contractor
Sciame Construction

Architect
Morris Adjmi Architects

Structural Engineer
Gilsanz Murray Steficek

Steel Detailer
International Design Services (AISC Member)